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The origin and interpretation of Bahia la Choya (Northern Gulf of California) taphocoenoses: implications for paleoenvironmental analysis

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With 2 Figures in the text

ABSTRACT

The analysis of ecological and taphonomic data preserved in skeletal elements of the benthic macrofauna of the Bahia la Choya macrotidal complex permits fine-scale discrimination of environments. Despite certain limitations, the combined paleoecological and taphonomic approach is a powerful tool for the recognition and interpretation of paleoenvironments.

ZUSAMMENFASSUNG

Die ökologische und taphonomische Analyse der schalentragenden benthonischen Makrofauna von Bahia la Choya erlaubt eine Feingliederung des Gezeitenbereichs der Bucht (vom flachen Subtidal bis zur supratidalen Marsch). Trotz gewisser Einschränkungen ist der kombinierte palökologische und taphonomische Ansatz sehr gut dafür geeignet, fossile Ablagerungsräume zu erkennen und zu analysieren.

INTRODUCTION

The taxonomic and ecological composition, the taphonomic signatures, and the distribution pattern of the shelly macrobenthos of the tidal flats of Bahia la Choya and of adjacent Pleistocene rocks have been described in detail (ABERHAN & FURSICH, FEIGE & FURSICH, FLESSA & FURSICH, FURSICH & SCHÖDLBAUER; all this volume). An outline of the physical environment of this macrotidal system near the head of the Gulf of California can be found in FURSICH et al. (this volume). In this paper we focus on the implications that our results have for paleoenvironmental analysis in general.

According to our studies of the shelly macrofauna of the Bahia la Choya tidal flat complex, composition and taphonomic characteristics of the taphocoenoses are affected by three major factors (Fig. 1):

(1) original species composition and relative abundance,
(2) taphonomic processes, and
(3) time.

In the following, we discuss the impact of each of these factors and conclude with a discussion of the limitations and strengths of our approach.

ORIGINAL SPECIES COMPOSITION AND RELATIVE ABUNDANCE

Original species composition and relative abundance of taxa at Bahia la Choya are controlled by a number of abiotic factors, the most important of which are substrate (in particular consistency and degree of stability), food distribution, duration of subaerial exposure, and energy level (FURSICH & SCHÖDLBAUER, this volume). The same factors control the distribution of trophic and substrate adaptations, that is the type of feeding and the mode of life. Of the biotic factors, chance settlement of larvae and settlement of opportunistic species

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are thought to be important. Finally, historic factors should not be overlooked, as they are responsible for composition of the species pool in the northern Gulf of California and for the affiliation of the fauna with the Panamic faunal province.

All these factors regulate a moderately diverse molluscan fauna, dominated by suspension-feeding bivalves and detritus-feeding/herbivorous gastropods. The fauna decreases in diversity from the shallow subtidal to the supratidal as a result of increasing environmental stress in the same direction. In contrast, the density of live fauna is highest in the supratidal marsh and inner tidal flats (caused by abundant herbivorous and detritus-feeding gastropods) and decreases seaward.

TAPHONOMIC PROCESSES

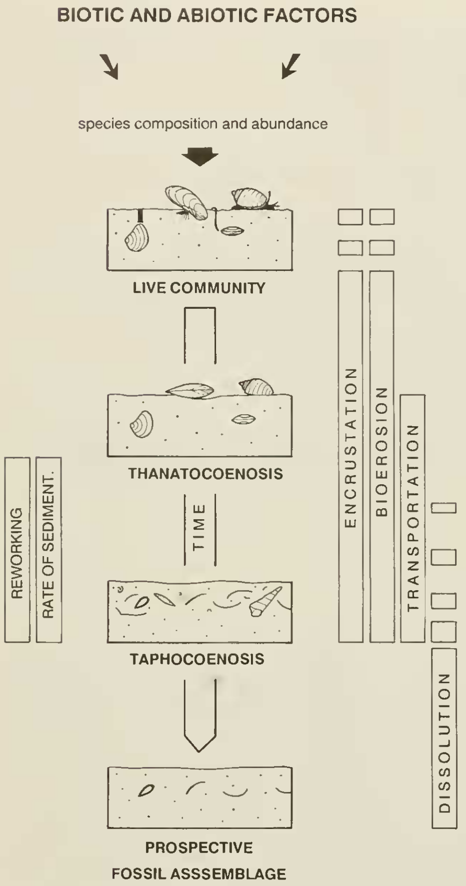

Fig. 1: Factors responsible for the transition from the live community to the prospective fossil assemblage in the tidal flat complex at Bahia la Choya.

In general, taphonomic processes have differential effects on different species depending on size, mineralogy and mechanical strength of the hardparts as well as on life habits (e. g. infaunal versus epifaunal) (Feige & Fürsich, this volume). This leads to changes in the relative abundance of species in taphocoenoses. In the following, the impact of the various taphonomic agents on the skeletal elements of the Bahia la Choya fauna is briefly discussed.

Transportation

Despite the high tidal range and resulting strong tidal currents, between-habitat transport of shells by physical agents is limited and largely confined to the main tidal channel. There, shells of taxa indicative of marsh and inner flat areas (e. g. *Cerithidea*, *Tagelus*) are transported in an offshore direction. Transport of gastropod shells (mainly *Cerithium*) is, in addition, caused by a biological agent, i. e. hermit crabs. This biogenic transport largely takes place in the mid channel area where most hermit crabs live. Another mode of transport, shell-floating, occurs when dried, convex-up shells are floated and carried landward on the incoming tide. However, this is not a volumetrically significant factor.

Transport can mainly be recognised by abrasion and the resulting loss of shell ornament, and by breakage. The activity of hermit crabs is indicated by selective abrasion caused by the shells being dragged across the surface in a certain position. In addition, ecological analysis of the faunal composition may reveal transported shells, if they represent modes of life not in accordance with that of the remaining fauna (e. g. elements of marsh fauna in outer flat environments). Finally, biofabric and orientation patterns (e. g. preferred convex-up orientation) of shells give hints as to the influence of currents and hence transport.

Abrasion and breakage

Abrasion and breakgage frequently occur in association with transport, but – largely when due to wave influence – may also occur within habitats. Not surprisingly, the highest degrees of abrasion and fragmentation occur in the tidal channel and in the outer flat region close to the breaker zone.

Abrasion of skeletal elements is strongly controlled by their shape (e. g. gastropod shells roll more easily than bivalves) and microarchitecture and depends on whether the shells are inhabited by hermit crabs (such gastropod shells are better preserved). Physical abrasion is often difficult to distinguish from bioerosion caused by endophytes. In addition, physical abrasion frequently destroys evidence of other taphonomic agents such as boring or encrustation.

Breakage is caused either by physical agents or by predatory organisms such as sea gulls, fish, and crabs. Biotic breakage patterns may be quite distinct. Breakage is greatly facilitated by a high degree of abrasion, maceration, and boring.

The taphonomic imprints left by abrasion and breakage are usually easily recognised and consist of broken or partly fragmented shells and loss of luster and shell ornament.

Bioerosion

Boring organisms include predators such as naticid and muricid gastropods and *Octopus*. The more or less circular holes they create are fairly diagnostic of their producers. This allows identification of fossil boreholes in many cases. Most borings, however, are created to provide protection for the producer. At Bahia la Choya such borings include the U-shaped tunnels of spionid polychaetes, interconnected chambers of clionid sponges, club-shaped cavities of bivalves, and the delicate imprints of ctenostome bryozoans (Feige & Fursich, this volume). Also very abundant are the minute tunnel systems of endophytes (algae, bacteria, and fungi). Their effect on shells is often difficult to distinguish from that of mechanical erosion (see above).

Erosion caused by boring organisms is a widespread feature on shells of the Bahia la Choya tidal flat. It is most pronounced in the outer flat and still common in shells from mid flat and outer to mid channel areas. There is a clear positive correlation between degree of bioerosion and residence time of shells on the sediment and therefore an inverse relationship between degree of bioerosion and rate of net sedimentation. The abundance of borings is also correlated with the period of time shells are submerged and with the mode of life of the host (epifaunal versus infaunal).

Encrustation

The most important encrusting organisms are serpulids, bryozoans, vermetid gastropods, balanids, foraminifera, and crustose coralline algae. Their preservation potential depends on skeletal mineralogy (e. g. aragonite versus calcite) and durability as well as on the preferred site of colonisation (organisms that preferentially encrust the umbonal cavity of bivalves fare better than those encrusting the shell exterior). The preservation potential of encrusters strongly depends on the degree of abrasion and bioerosion the encrusted shells are subject to. On the other hand, encrustation enhances the preservation potential of the host shell. Encrustation may protect the shell from breakage, abrasion, and bioerosion.

Encrustation is most abundant on the outer shelf and in the tidal channel. There is a clear relationship – as in the case of borers – with low rates of net sedimentation and time of submergence. Furthermore, epifaunal species are more subject to encrustation than infaunal ones, as the former can be encrusted while alive, whereas in the latter encrustation only takes place post-mortem and requires exhumation.

Dissolution

At Bahia la Choya dissolution of shells only occurs in the channel draining the salt marsh (estero channel) and in the salt marsh itself. Dissolution can be explained by the acidic pore water of the marsh sediments. Apart from showing solution pits and general loss of shell substance, many of the shells have a chalky appearance caused by maceration. In some cases dissolution apparently starts while the shells are alive, but continues after burial. It is a process that generally takes considerably more time than any of the taphonomic processes discussed earlier.

The distinctive texture and features caused by dissolution often oversprint and obliterate other taphonomic features such as abrasion, bioerosion, and encrustation.

Reworking

Reworking is either caused by physical or biological processes and is related therefore to the energy level, the rate of net sedimentation or the population density of infaunal organisms. In many cases reworking results in the formation of skeletal concentrations. At Bahia la Choya three time frames of reworking can be recognised:

(1) short term (10^1 to 10^3 yrs),
(2) medium term (10^3 yrs), and
(3) long term (10^4 to 10^5 yrs).

Short term reworking refers to bioturbation, migration of tidal channels, storm erosion and redeposition. This time frame can be recognised by burrows, erosion surfaces, and the biofabric of skeletal concentrations. Short term reworking is an ubiquitous feature across the tidal flat, channel, and marsh. Physical processes dominate in the outer to mid shelf areas and the channel, whilst biological agents are more pronounced in inner flat and marsh.

Reworking over intermediate time frames is caused by erosion of skeletal elements from the shelly spit and their incorporation in the Recent fauna of the tidal flat or salt marsh. This process can be recognised by ecological incompatibility of faunal elements and by their different taphonomic signatures. An example of ecological incompatibility is the presence of lower intertidal to subtidal taxa such as *Dosinia* and *Pteria* in sediments of the salt marsh or the salt marsh channel ("estero"). An example of a distinctive taphonomic signature is the typical abrasion texture exhibited by taxa from the spit. Due to a different taphonomic history shells of the gastropod *Cerithidea* from the spit are strongly polished and can easily be distinguished from *Cerithidea* shells of the inner flat or marsh which – even when strongly abraded – lack the smooth surface of the spit specimens.

Reworking representing long periods of time is caused by erosion of shells from the Pleistocene rocks that surround Bahia la Choya and those that crop out particularly in the northern part of the bay. Pleistocene components are most easily recognised by their matrix that still adheres to shells and differs in composition and degree of lithification from Recent sediments. Pleistocene shells eroded from the banks of the estero channel differ by being highly chalky and by having lost luster and color. They also differ drastically in composition from the surrounding salt marsh and estero channel fauna (Fursich & Flessa 1987).

Rate of sedimentation

Due to limited sediment input into the northern Gulf of California, rates of sedimentation at Bahia la Choya are rather low. Within the bay, net sedimentation rates approach zero in the northern part, but are higher in the southern part, particularly in the inner flat. The low rate of net sedimentation strongly affects the residence time of shells on the sediment surface and thus the impact of taphonomic processes such as bioerosion and encrustation. It ist partly responsible for the high shell density across much of the tidal flats. Furthermore, the rate of sedimentation decisively influences the degree of time-averaging of the fauna (see below).

TIME

The time factor is closely related so sedimentation rate and rate of shell production and thus influences the shell density as well as the intensity of many taphonomic features. Time-averaging, the mixing of skeletal elements of non-contemporaneous populations or communities (WALKER & BAMBACH 1971), is consequently common and widespread in Bahia la Choya. The time span involved is up to 100000 years (in the case of reworked Pleistocene skeletal elements); more often a time range of several thousand years is represented (MELDAHL 1987). Time-averaging is caused either by physical reworking of the sediment in conjunction with extremely low net sedimentation rates, or else by biological reworking (e. g. by populations of the ghost shrimp *Callianassa* on the inner flat – see MELDAHL 1987). Time-averaging is easily recognised in the case of introduction of shells from the Pleistocene or from the subrecent spit where either the taphonomic signatures differ substantially or else ecological incompatibility exists. In these cases, time-averaging is, strictly speaking, allochthonous (FURSICH & ABERHAN 1990). Short autochthonous time-averaging is recognised, for example, by the abundance of the small bivalve *Parivilucina mazatlanica* in taphocoenoses of the outer to midflat, whilst in the living communities this bivalve is extremely rare.

The use of faunal composition to infer time-averaging is, however, strongly limited in the fossil record where the precise composition of living assemblages is often not known. In such cases time-averaging may be recognised by using the frequency distribution of the taphonomic condition of the skeletal elements. Fig. 2 shows schematically four "taphograms" of skeletal elements (comparable to psychograms of human populations) from hypothetical samples. In our opinion, they allow inferences about the presence/absence and intensity of time-averaging.

In taphogram A all skeletal elements are poorly preserved and exhibit a narrow peak along the preservation gradient. This implies that the rate of shell destruction is much higher than the rate of shell production. Such a taphogram could result from transport or winnowing and generally reflects a uniform taphonomic history of the shells. Time-averaging cannot be inferred. If however shell distribution along the preservation gradient is polymodal, then this will most likely reflect discontinuous time-averaging (FURSICH & ABERHAN 1990).

Taphogram B shows a broad distribution of shells with a modest peak at poor conditions. Here, the rate of destruction is higher than the rate of shell production. The presence of many different modes of preservation reflects different taphonomic histories and is thus indicative of time-averaging.

In taphogram C we encounter a broad distribution of shells along the preservation gradient with a modest peak at good condition. This is a result of the rate of shell production being higher than the rate of destruction. As argued for taphogram B, the presence of different modes of preservation reflects time-averaging.

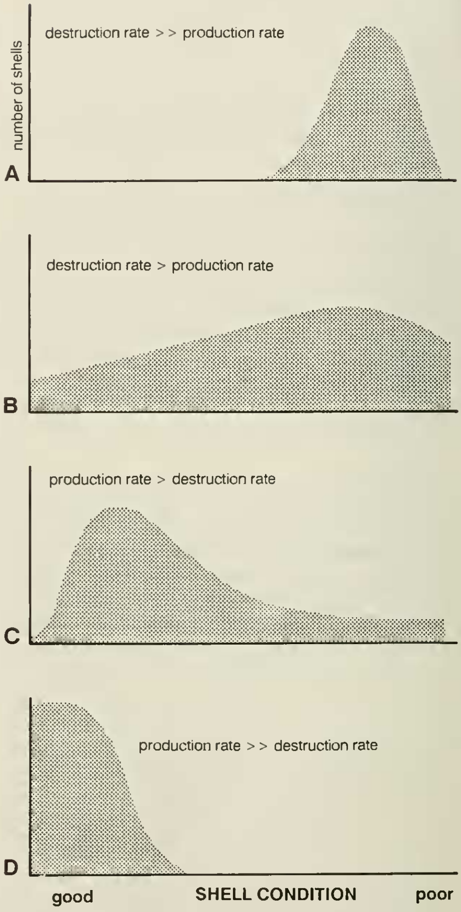

Fig. 2: Model of the frequency distribution of the taphonomic condition of skeletal elements ("taphograms"). For explanation see text.

Finally, taphogram D exhibits a narrow peak and all shells are well preserved. The rate of shell production by far exceeds the rate of shell destruction. Such conditions result for example from rapid burial of shells. The lack of an extensive and varied taphonomic history shows that time-averaging did not play any role.

Apart from the analysis of taphograms, there are additional lines of evidence that can be used to recognise time-averaging in Bahia la Choya and elsewhere in the fossil record and crudely estimate the minimum length of time involved. They include cross-cutting borings in shells. This relationship implies filling of the first generation of boreholes with sediment and lithification of the fill, most likely during a burial phase of the shell, prior to subsequent attack by a second generation of borers. Another example is a partially eroded boring that is overgrown by epizoans. In this case substantial erosion involving a certain length of time has taken place between the two colonisation phases. Finally, shells with attached matrix that differs from the surrounding sediment are another clear sign of non-contemporaneity and hence time-averaging.

Although not immediately apparent, the time factor exerts great influence on the composition and preservation of skeletal elements. For this not hundred thousands or even millions of years need to be involved, but a few thousand or even only a few hundred years will suffice, as the Bahia la Choya example shows.

INTEGRATED APPROACH TO PALEOENVIRONMENTAL ANALYSIS

Paleoenvironmental analyses are usually carried out by sedimentologists. In the last few decades, the contribution paleoecologists and ichnologists can make to fine-tuning paleoenvironments has been recognised (e. g. SEILACHER 1967, DODD & STANTON 1981). In the last few years, taphonomy has been added as a tool to decipher environmental processes (e. g. BRETT & BAIRD 1986). In combining faunal and trophic/substrate information with information from taphonomic signatures of skeletal elements (combining studies of biofacies and taphofacies), paleontology can significantly contribute to paleoenvironmental analysis. As our studies of the tidal flat complex at Bahia la Choya have shown, there are limitations to this approach in the fossil record: Life habit and trophic data (in particular of gastropods) may be difficult to retrieve, because information from living representatives or analogs is required. The time factor strongly influences diversity and other ecological data as do taphonomic processes that selectively remove components of the fauna. Taphonomic features may not be preserved, or may be thoroughly overprinted.

Set against these limitations are the strengths of the combined approach. Faunal and trophic data allow inferences about the distribution of food and its availability in the sediment versus the water column, and thus indirectly about the energy level. Faunal/trophic data yield also information about stress gradients caused by abiotic environmental factors such as oxygen, salinity, or time of subaerial exposure. Taphonomic features furnish information about the energy level, reworking events, degree of transport, rate of sedimentation, and time frames. Gaining an idea of the latter enables us to adequately interpret ecological data, in particular diversity.

The example of Recent sediments and Pleistocene rocks at Bahia la Choya illustrates that use of both approaches permits fine-scale discrimination of environments and thus is indeed a powerful tool for paleoenvironmental analysis.

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Appendix 1

Distribution of live fauna along Transect A.
Numbers refer to individuals per 9 l sediment sample.

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
BIVALVES																						
Cardita affinis	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chione californiensis	-	-	-	-	-	3	-	-	4	-	2	-	6	-	-	-	-	-	-	-	-	-
Chione fluctifraga	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Donax navicula	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dosinia dunkeri	-	-	-	-	-	-	-	-	4	-	-	3	-	-	-	-	-	-	-	-	-	-
Felaniella sericata	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lucina lampra	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Mytella guyanensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Parvilucina mazatlanica	-	-	-	2	4	-	3	9	2	2	2	3	-	-	2	-	-	-	-	-	-	-
Protothaca grata	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	3	1	1	-	-	-	-
Strigilla interrupta	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tagelus affinis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1	1	1	1	1	1	-
Tellina carpenteri	-	-	-	-	-	-	-	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-
GASTROPODS																						
Agaronia testacea	8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anachis nigricans	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cerithidea mazatlanica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	8	15	44	84	28	11	289
Cerithium stercusmuscarum	-	-	-	714	4	39	18	9	16	6	4	27	12	72	22	22	2	1	-	-	1	-
Crassispira kluthi	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crepidula striolata	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nassarius brunneostoma	-	-	-	-	-	-	-	-	2	8	10	12	6	12	18	10	13	30	112	43	15	-
Nassarius iodes	-	-	-	-	-	15	3	21	36	18	34	33	24	40	18	1	7	-	7	2	-	-
Nassarius tiarula	-	-	-	-	2	3	9	3	-	-	2	3	-	-	-	-	-	-	-	-	-	-
Oliva spicata	-	-	-	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Pedipes unisulcatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Solenosteira macrospira	-	-	-	4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terebra armillata	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Theodoxus luteofasciatus	-	-	-	8	6	3	3	3	-	-	-	-	-	4	2	-	-	-	-	-	-	-
BRACHIOPODS																						
Glottidia sp.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ECHINOIDS																						
Encope micropora	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mellita longifissa	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
total number of specimens /9 l	11	4	3	742	24	66	39	48	72	34	54	84	48	128	70	45	39	77	204	74	28	295

Appendix 2

Distribution of live fauna along Transect B.
Numbers refer to individuals per 9 l sediment sample.

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
BIVALVES																								
Chione californiensis	-	-	-	-	-	1	1	2	-	1	-	3	-	1	1	-	-	-	-	6	-	-	-	-
Cooperella subdiaphragma	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corbula marmorata	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diplodonta subquadrata	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Donax navicula	-	-	-	1	2	-	5	6	5	2	-	3	-	6	3	4	1	3	-	-	-	-	-	-
Dosinia dunkeri	-	-	-	-	-	-	-	2	1	2	1	2	-	1	-	-	-	-	-	-	-	-	-	-
Felaniella sericata	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Lucina lampra	-	-	-	-	-	1	-	3	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Parvilucina mazatlanica	-	-	2	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Protothaca grata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	2	90	27	-	-	-	-
Strigilla interrupta	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tagelus affinis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	3	-	3	-	-	-	-	-
GASTROPODS																								
Agaronia testacea	3	8	-	1	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cerithidea mazatlanica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	3	4	114	12	-
Cerithium stercusmuscarum	-	-	-	-	-	1	1	-	-	1	1	-	189	2	12	-	1	1	345	642	-	-	-	-
Nassarius brunneostoma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	15	3	2	1	-	-
Nassarius iodes	-	-	-	6	10	20	4	25	16	39	21	60	30	22	19	21	17	1	78	-	-	-	-	-
Nassarius tiarula	-	-	-	-	-	-	-	-	-	-	-	1	9	-	-	-	-	-	-	-	-	-	-	-
Terebra armillata	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Theodoxus luteofasciatus	-	-	-	-	1	1	-	-	6	-	-	4	102	1	-	1	1	-	1	381	-	-	-	-
ECHINOIDS																								
Encope micropora	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mellita longifissa	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
total number of specimens/9 l	8	8	14	9	16	26	11	43	28	47	25	73	330	33	36	30	26	7	547	1062	6	115	12	0

Appendix 3

Distribution of live fauna along Transect C.
Numbers refer to individuals per 9 l sediment sample.

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
BIVALVES																								
Atrina sp.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cardita affinis	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chama sp.	-	-	-	-	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Cerithidea mazatlanica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Chione californiensis	-	-	-	-	2	-	-	-	-	1	-	-	1	-	1	-	-	-	-	-	-	-	-	-
Chione fluctifraga	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Corbula marmorata	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Donax gracilis	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Donax navicula	-	-	-	-	-	-	-	-	1	-	-	1	1	1	2	1	-	-	1	1	1	-	-	-
Dosinia dunkeri	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-
Lucina lampra	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Modiolus capax	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nucula declivis	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parvilucina mazatlanica	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	1	-	-
Protothaca grata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Strigilla interrupta	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tagelus californianus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Tagelus sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
GASTROPODS																								
Agaronia testacea	8	4	1	2	-	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Agladrillia pudica	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Anachis adelinae	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anachis sanfelipensis	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anachis nigricans	-	-	-	-	-	-	1	2	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Anachis varia	-	-	-	-	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arene fricki	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cerithium stercusmuscarum	-	-	-	1	1	322	-	2	-	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Columbella strombiformis	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Conus sp.	-	-	-	1	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Conus regularis	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Crassispira kluthi	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cymatium gibbosum	-	-	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Nassarius brunneostoma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	1	2	1	17
Nassarius iodes	-	4	-	3	-	-	-	2	8	6	1	7	4	3	11	5	7	13	5	10	2	1	-	-
Nassarius tiarula	-	-	-	-	-	1	1	-	1	-	2	2	-	-	1	-	-	-	-	-	-	-	-	-
Natica chemnitzii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Oliva spicata	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Olivella dama	-	-	-	2	10	2	1	-	6	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Pilsbryspira bacchia	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pilsbryspira garciacubasi	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solenosteira macrospira	-	-	-	-	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terebra armillata	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
Turritella sp.	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
ECHINOIDS																								
Mellita longifissa	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
total number of specimens/9 l	14	8	1	10	23	344	7	9	21	15	10	14	9	6	17	8	8	14	6	13	4	6	2	20

Appendix 4

Distribution of live fauna along Transect D.
Numbers refer to individuals per 9 l sediment sample.

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
BIVALVES																		
Cardita affinis	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Chama sp.	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Chione fluctifraga	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Chione californiensis	1	2	-	-	4	2	-	-	1	1	1	-	-	-	1	1	-	-
Corbula marmorata	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
Donax navicula	-	-	-	-	-	-	1	1	1	6	2	5	-	-	5	-	-	-
heterodont sp. H	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Lucina lampra	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Megapitaria squalida	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Modiolus capax	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Orobitella zorrita	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Parvilucina mazatlanica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Protothaca grata	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-
Tellina coani	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tellina meropsis	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Tivela byronensis	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
GASTROPODS																		
Agaronia testacea	2	8	-	2	-	-	1	-	-	1	-	-	-	-	-	-	-	-
Anachis adelinae	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anachis nigricans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
Anachis varia	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cerithium stercusmuscarum	-	-	103	4	2	11	1	5	-	31	22	8	26	15	9	2	2	50
Olivella dama	4	-	-	4	6	-	-	-	-	-	-	-	-	-	-	-	-	-
Nassarius brunneostoma	-	-	-	-	-	1	-	-	-	-	2	-	13	9	8	6	-	14
Nassarius iodes	-	-	-	-	-	-	7	11	7	1	6	-	8	5	8	10	1	-
Nassarius tiarula	-	-	-	-	-	-	-	-	1	2	1	-	-	-	-	-	-	-
Pilsbryspira garciacubasi	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Solenosteira macrospira	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
Theodoxus luteofasciatus	-	-	-	-	-	-	-	-	-	2	2	5	4	6		-	-	11
total number of specimens/9l	13	10	107	12	15	22	10	18	11	44	36	18	52	35	31	20	7	77

Appendix 5

Distribution of shells within taphocoenoses along Transect A.
Only those taxa are listed which represent one or more percent of the individuals within the particular sample.
Numbers refer to individuals.

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
BIVALVES																						
Arcopsis solida	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Argopecten circularis	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asthenothaerus villosior	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barbatia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Cardita affinis	13	2	2	-	12	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chione sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-
Chione californiensis	3	1	9	118	196	189	202	348	314	286	488	492	678	576	100	5	-	-	-	-	-	-
Chione mariae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corbula marmorata	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cryptomya californica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	1	3
Cyclopecten pernomus	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diplodonta orbella	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diplodonta orbicularis	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diplodonta subquadrata	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Donax gracilis	6	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Donax navicula	-	1	6	64	32	36	75	117	126	110	268	189	264	276	64	2	1	-	1	-	-	-
Dosinia dunkeri	2	2	4	16	-	-	-	-	30	-	-	51	96	-	-	-	-	-	-	-	-	-
Felaniella sericata	2	1	17	38	30	51	147	168	186	172	264	312	303	-	101	-	1	-	1	-	-	-
Glycymeris multicostata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Isognomon ianus	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Laevicardium elenense	13	-	7	16	-	-	-	-	-	-	-	-	-	-	26	4	1	-	-	-	-	-
Lucina sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Lucina lampra	2	4	12	74	122	198	582	591	582	456	712	648	978	896	234	4	-	-	-	1	-	-
Megapitaria squalida	-	2	8	28	42	39	120	93	92	56	82	81	96	96	26	-	-	-	-	1	-	-
Ostrea sp.	2	7	-	-	12	-	-	-	-	-	-7	-	-	-	-	-	-	-	-	-	-	-
Orobitella cf. *zorrita*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Pandora uncifera	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parvilucina approximata	-	2	3	-	-	-	36	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parvilucina mazatlanica	8	1	22	280	118	102	1008	837	1106	648	1864	2709	1725	1240	628	29	1	-	-	-	-	-
Parviculina prolongata	4	-	3	-	-	-	-	-	-	-	-	-	72	-	-	2	-	-	-	-	-	-
Phlyctiderma discrepans	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pitar helenae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Protothaca grata	-	-	2	34	14	-	-	48	-	34	48	60	117	100	46	2	-	-	1	-	1	-
Pteria sterna	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Semele guaymasensis	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphenia fragilis	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strigilla interrupta	11	6	-	-	-	-	-	-	32	28	64	72	81	80	30	-	-	-	-	-	-	-
Tagelus affinis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1	-
Tellina amianta	4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tellina brevirostris	-	-	-	-	-	-	-	36	-	24	-	-	-	-	-	-	-	-	-	-	-	-
Trachycardium panamense	2	1	2	12	12	33	51	60	52	34	60	78	63	64	38	3	-	-	-	1	-	-
Tellina coani	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODS																						
Agaronia testacea	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Calyptraea mamillaris	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Collisella turveri	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cerithidea mazatlanica	-	-	-	48	44	63	33	60	-	48	-	144	138	204	112	15	4	5	4	10	25	251
Cerithium stercusmuscarum	-	-	6	218	219	225	138	93	56	94	-	144	231	368	218	24	16	4	2	-	1	3
Collisella turveri	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Crepidula excavata	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crepidula striolata	-	1	2	16	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crepidula unicata	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crucibulum spinosum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Melampus mousleyi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Nassarius brunneostoma	-	-	-	28	16	27	-	-	-	-	-	-	-	-	2	-	3	4	5	1	11	-
Nassarius iodes	-	-	-	44	32	63	42	63	36	-	-	105	207	212	74	7	5	2	1	1	-	3
Olivella dama	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Pedipes unisulcatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Theodoxus luteofasciatus	-	-	-	18	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vermetus indentatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Dentalium semipolitum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	-	-	-	-	-	-	-
number of additional taxa (representing <1% each)	16	0	13	35	34	33	49	48	56	46	60	55	53	55	41	20	0	0	0	0	0	7

Appendix 6

Distribution of shells within taphocoenoses along Transect B.
Only those taxa are listed which represent one or more percent of the individuals within the particular sample.
Numbers refer to individuals.

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
BIVALVES																								
Arca pacifica	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arcopsis solida	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Asthenosthaerus villosior	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cardita affinis	5	4	-	-	-	-	8	4	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Chione californiensis	3	28	-	51	8	52	39	49	62	32	17	87	261	19	6	-	7	4	-	30	1	2	93	29
Chione fluctifraga	-	-	-	17	9	-	-	6	14	-	-	12	81	19	9	5	4	-	-	-	-	-	-	-
Chione pulicaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Corbula marmorata	2	4	-	-	-	5	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	12
Crassostrea corteziensis	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	27	-
Cryptomya californica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-
Cumingia lamellosa	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diplodonta orbella	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diplodonta subquadrata	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Donax gracilis	7	14	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Donax navicula	2	4	2	45	8	40	70	48	80	41	-	58	171	23	12	4	8	4	-	-	2	2	72	35
Dosinia dunkeri	-	-	-	20	2	5	-	4	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Felaniella sericata	-	-	2	78	11	48	66	10	42	32	6	31	54	11	11	3	-	3	-	-	-	-	60	8
Glycymeris multicostata	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
heterodont bivalve	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-
Hiatella arctica	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Laevicardium elenense	30	16	4	16	3	8	15	6	15	8	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Lucina lampra	4	-	2	95	11	78	118	55	77	67	18	103	297	20	10	6	4	4	-	-	-	2	150	58
Megapitaria squalida	2	14	2	18	5	12	16	9	10	8	4	-	-	-	-	-	-	1	-	-	-	-	-	4
Modiolus capax	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orobitella zorrita	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ostrea sp.	10	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parvilucina approximata	2	4	-	-	-	-	-	5	-	-	2	-	-	-	-	-	-	-	-	-	1	-	-	-
Parvilucina mazatlanica	5	6	-	205	51	107	204	79	231	127	44	65	171	-	20	4	6	3	-	-	-	2	48	44
Parvilucina prolongata	3	4	-	8	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	1	-	33	24
Petricola exarata	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pitar helenae	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Protothaca grata	-	-	-	-	-	-	23	18	23	24	5	10	153	32	10	4	-	-	42	30	-	2	78	20
Strigilla interrupta	12	4	-	26	4	12	-	7	12	8	4	-	-	-	-	-	-	2	-	1	-	-	-	-
Tagelus affinis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-
Tellina amianta	5	14	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tellina carpenteri	-	-	-	9	2	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tellina coani	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thracia squamosa	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trachycardium panamense	4	-	2	9	3	8	10	4	13	8	2	9	-	-	-	-	-	1	-	-	-	-	-	13
GASTROPODS																								
Agaronia testacea	-	8	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-
Calyptraea mamillaris	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cerithidea mazatlanica	-	-	-	-	-	6	-	-	45	11	5	99	1586	250	118	30	26	3	201	450	5	18	606	54
Cerithium stercusmuscarum	-	-	1	-	6	14	-	8	14	11	-	47	2781	328	96	22	23	1	486	639	1	10	219	18
Collisella acutapex	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Crepidula striolata	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Crepidula uncata	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crucibulum concameratum	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Crucibulum spinosum	2	6	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nassarius brunneostoma	-	-	-	-	-	-	-	-	-	-	-	-	180	21	17	-	2	1	24	-	-	7	72	5
Nassarius iodes	-	-	-	-	-	2	11	-	-	17	12	-	46	1089	183	17	18	10	1	-	1	-	60	12
Nassarius tiarula	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	1	-
Oliva spicata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Olivella dama	2	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-
Terebra armillata	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Theodoxus luteofasciatus	-	-	-	-	-	-	-	-	-	-	-	-	847	105	10	-	2	-	213	192	-	-	-	-
Turbo sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Vermetus indentatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	15	15	1	4	-	9
number of additional taxa (representing <1% each)	17	18	0	49	35	39	48	38	36	34	8	37	30	40	23	12	10	0	19	10	0	12	39	19

Appendix 7

Distribution of shells within taphocoenoses along Transect C.
Only those taxa are listed which represent one or more percent of the individuals within the particular sample.
Numbers refer to individuals.

Stations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
BIVALVES																								
Arcopsis solida	8	-	1	10	14	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aligena cokeri	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Anomia adamas	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arca pacifica	-	-	-	9	22	-	2	-	6	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Argopecten circularis	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cardita affinis	12	28	1	36	68	40	1	28	13	30	7	14	3	-	-	-	-	-	-	-	-	-	-	-
Chama mexicana	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chione californiensis	52	92	3	97	160	90	12	58	16	110	4	15	10	74	68	2	11	13	13	17	6	8	10	18
Chione fluctifraga	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2	-	-	-
Chione squamosa	7	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corbula bicarinata	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corbula marmorata	29	24	1	18	26	-	2	8	4	10	2	-	-	-	-	-	-	-	-	-	-	17	-	-
Cryptomya californica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Ctena mexicana	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cummingia lamellosa	-	8	1	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diplodonta orbella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Diplodonta subquadrata	7	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Donax gracilis	16	28	-	10	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Donax navicula	-	8	3	13	20	14	2	16	12	30	12	29	32	68	88	6	10	22	13	11	5	4	7	24
Dosinia dunkeri	-	-	-	-	-	-	2	-	2	-	2	5	-	-	18	2	2	-	-	-	-	1	-	4
Felaniella sericata	-	-	-	-	-	-	1	12	8	21	6	36	18	79	111	6	8	22	19	13	5	12	6	18
Glycymeris multicostata	11	12	-	16	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gregariella coarctata	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Laevicardium elenense	32	28	10	8	18	-	1	6	3	8	9	5	4	-	-	5	-	4	-	-	-	-	2	-
Lucina lampra	-	12	1	31	64	58	10	96	41	92	47	116	86	327	324	14	37	45	33	42	35	20	18	50
Macoma indentata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-	3	2	2	1	-	-
Megapitaria squalida	7	40	3	24	80	34	5	16	8	24	6	9	8	30	39	2	2	-	3	-	2	-	2	8
Modiolus capax	5	-	1	13	-	-	1	10	4	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nucula declivis	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ostrea sp.	6	12	1	18	52	40	4	10	7	15	4	5	-	-	-	1	-	-	-	-	-	-	2	4
Parvilucina approximata	-	3	-	16	58	16	1	6	5	9	3	4	3	15	-	-	2	-	2	3	-	-	2	-
Parvilucina mazatlanica	-	8	4	27	-	46	7	26	14	36	25	52	41	63	262	28	33	72	59	19	16	17	22	59
Parvilucina prolongata	-	3	-	-	24	18	1	8	3	8	4	5	4	17	20	1	2	3	-	2	1	-	-	3
Phlyctiderma discrepans	-	-	1	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Pitar helenae	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	3
Protothaca grata	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	4	-	-	2	4	9
Pteria sterna	102	64	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strigilla interrupta	-	-	-	-	-	16	2	-	2	9	4	8	6	-	15	4	2	-	2	-	-	1	-	6
Tagelus affinis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
Tagelus californianus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	4	-
Tellina amianta	13	48	1	12	28	16	4	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-
Tellina brevirostris	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Tellina carpenteri	-	-	-	-	-	-	-	-	-	-	-	6	3	-	-	2	-	3	-	-	1	-	-	-
Tellina coani	7	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tellina meropsis	-	-	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tellina simulans	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
Thracia curta	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trachycardium panamense	-	-	-	10	14	-	1	6	-	7	3	4	-	-	14	2	2	-	2	2	1	1	-	3
Trigoniocardia biangulata	6	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
GASTROPODS																								
Agaronia testacea	7	-	17	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agladrillia pudica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Anachis adelinae	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bulla gouldiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Calyptraea mamillaris	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Cerithidea mazatlanica	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	3	4	-
Cerithium stercusmuscarum	-	-	-	-	294	494	3	34	4	26	2	-	-	-	-	-	-	-	3	-	-	1	-	-
Columbella strombiformis	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crepidula excavata	-	8	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crepidula incurva	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crepidula striolata	-	-	1	-	-	20	4	6	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Crepidula uncata	9	-	-	9	-	-	1	-	2	6	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Crucibulum sp.	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Stations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Crucibulum spinosum	5	-	3	-	-	-	2	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
Diodora alta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Diodora inaequalis	-	-	-	-	26	-	2	-	2	7	-	-	-	-	-	-	-	-	-	-	-	-		
Diodora inaequistriata	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lucapinella milleri	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oliva spicata	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Olivella dama	-	-	-	-	-	-	1	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nassarius brunneostoma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	5	-
Nassarius iodes	-	-	-	-	22	18	1	-	-	7	-	8	-	-	-	-	-	4	3	-	-	2	2	-
Nassarius tiarula	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terebra armillata	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vermetus indentatus	-	8	-	-	-	14	2	6	4	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vermicularia pellucida	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
number of additional taxa (representing <1% each)	46	23	0	65	58	58	0	28	20	48	22	24	25	39	42	11	12	23	18	11	5	0	10	14

Appendix 8

Distribution of shells within taphocoenoses along Transect D.
Only those taxa are listed which represent one or more percent within the particular sample.
Numbers refer to individuals.

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
BIVALVES																		
Arca pacifica	-	-	3	12	-	6	-	-	-	-	-	1	-	-	-	1	-	-
Arcopsis solida	7	10	-	-	6	7	-	5	-	3	-	3	3	-	-	-	5	-
Argopecten circularis	13	-	-	10	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Barbatia rostae	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
Cardita affinis	31	22	3	-	26	37	9	18	28	5	5	4	11	13	23	8	26	14
Chione californiensis	110	112	5	274	52	73	34	48	22	5	24	6	28	54	131	17	65	107
Chione cortezi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	
Chione fluctifraga	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	1	-	-
Chione mariae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Chione squamosa	9	-	-	-	-	-	2	-	-	-	-	-	-	-	-	1	-	-
Corbula sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Corbula bicarinata	-	-	-	-	-	-	2	-	-	-	2	-	-	-	-	-	-	-
Corbula marmorata	35	14	-	40	13	21	7	14	18	-	4	3	9	22	29	6	24	17
Crassostrea corteziensis	-	-	-	32	-	-	-	-	-	-	-	-	3	-	-	1	9	12
Cumingia lamellosa	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-
Donax gracilis	13	14	-	18	5	-	-	-	-	2	-	-	-	-	-	1	-	-
Donax navicula	-	3	2	-	8	8	4	8	18	3	4	9	11	13	41	10	18	10
Dosinia ponderosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Felaniella sericata	-	-	-	-	-	-	-	-	-	-	2	2	-	-	10	2	7	7
Glycymeris multicostata	8	-	2	30	8	-	3	3	7	-	2	-	4	4	7	2	-	-
Laevicardium elenense	68	4	-	12	12	-	-	-	-	-	2	2	-	-	-	-	-	-
Lucina lampra	8	18	2	44	19	8	2	6	22	3	9	7	20	32	56	12	42	27
Megapitaria squalida	-	26	54	12	7	4	5	7	-	4	2	4	7	17	2	8	-	
Modiolus capax	-	-	4	-	-	-	2	-	-	-	-	-	-	-	-	-	-	12
Ostrea sp.	22	26	2	-	-	11	-	-	7	-	-	1	-	8	-	1	-	-
Parvilucina approximata	-	-	-	20	4	-	-	3	4	-	-	-	3	-	9	3	-	-
Parvilucina mazatlanica	11	12	2	48	24	17	3	7	7	3	5	4	5	12	17	3	16	12
Parvilucina prolongata	-	4	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-
Phlyctiderma discrepans	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-
Protothaca grata	-	-	-	-	-	-	-	-	-	-	-	1	12	54	24	5	12	10
Pteria sterna	77	18	-	28	11	13	2	4	-	2	2	-	-	-	-	1	-	-
Saccostrea palmula-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	
Semele sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Semele guaymasensis	-	6	-	10	-	-	-	-	4	-	-	-	-	-	8	-	-	-
Sphenia fragilis	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	1	-	-
Strigilla interrupta	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Tagelus affinis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Tellina sp.	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Tellina amianta	28	-	-	26	6	-	-	3	7	-	-	-	-	-	-	1	-	-
Tellina coani	10	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
Tellina meropsis	10	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tellina simulans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Trachycardium panamense	-	-	-	10	5	6	-	3	-	-	2	3	2	-	-	-	-	-
Trigoniocardia biangulata	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
GASTROPODS																		
Agaronia testacea	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-
Anachis nigricans	-	-	-	-	-	-	-	-	-	-	-	-	5	6	7	-	-	9
Anachis varia	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cerithium stercusmuscarum	-	-	90	26	19	90	6	43	38	44	17	6	29	35	132	1	46	195
Crepidula onyx	-	-	-	10	4	-	-	-	-	-	-	1	-	-	-	-	-	-
Crepidula incurva	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
Crepidula striolata	-	-	-	10	7	17	3	7	9	-	3	3	-	-	-	-	-	-
Crepidula uncata	8	8	-	-	-	8	-	5	-	-	3	-	-	-	-	-	-	-
Crucibulum spinosum	25	-	2	-	-	-	-	7	5	-	-	1	-	-	-	-	-	-
Diodora inaequalis	-	5	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-
Nassarius brunneostoma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	12
Nassarius guaymasensis	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nassarius iodes	-	-	-	-	-	-	-	4	-	-	2	-	4	14	14	-	7	16
Olivella dama	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
Serpulorbis oryzata	-	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-	-	
Theodoxus luteofasciatus	-	-	-	-	-	-	-	-	-	6	2	-	-	-	16	-	9	7
Vermetus indentatus	-	-	8	72	55	71	2	20	33	19	12	4	7	27	24	-	16	45
number of additional taxa (representing <1% each)	58	31	23	50	47	54	21	29	38	21	41	15	37	33	51	0	42	55